

**A NEW SPECIES OF *MEGASTIGMUS* DALMAN (HYMENOPTERA:
TORYMIDAE) REARED FROM SEEDS OF ATLANTIC WHITE CEDAR
(CUPRESSACEAE), WITH NOTES ON INFESTATION RATES**

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Abstract.—A new species, *Megastigmus thyoides* Kamijo (Hymenoptera: Torymidae), which emerged from seeds of Atlantic white cedar, *Chamaecyparis thyoides* (L.) B.S.P., collected in eastern United States is described and illustrated. This is the first record of this genus exploiting seeds of Cupressaceae in the Nearctic region. An average of 7% of the seeds collected from five sites in North Carolina were infested with this seed chalcid.

Key Words: Hymenoptera, Torymidae, *Megastigmus thyoides*, new species, *Chamaecyparis thyoides*, seed chalcid

For several tree species, insects often represent the most important source of seed mortality during the pre-dispersal phase of seed development (i.e., while still developing on the tree). Most insects exploiting the seed cones of commercially important conifers native to North America have already been identified, as surveys over the past 30 years have focused almost entirely on these trees (Miller et al. 1995, Turgeon et al. 1994). Conversely, knowledge of the entomofauna of native conifers that are of lesser economic importance is scarce. During a survey initiated in 1994 to address some of these knowledge gaps, we discovered specimens of an undescribed species of *Megastigmus* Dalman (Hymenoptera: Torymidae) feeding in seeds of Atlantic white cedar, *Chamaecyparis thyoides* (L.) B.S.P. (Cupressaceae). This species is described below and the rates of seed infestation observed are presented.

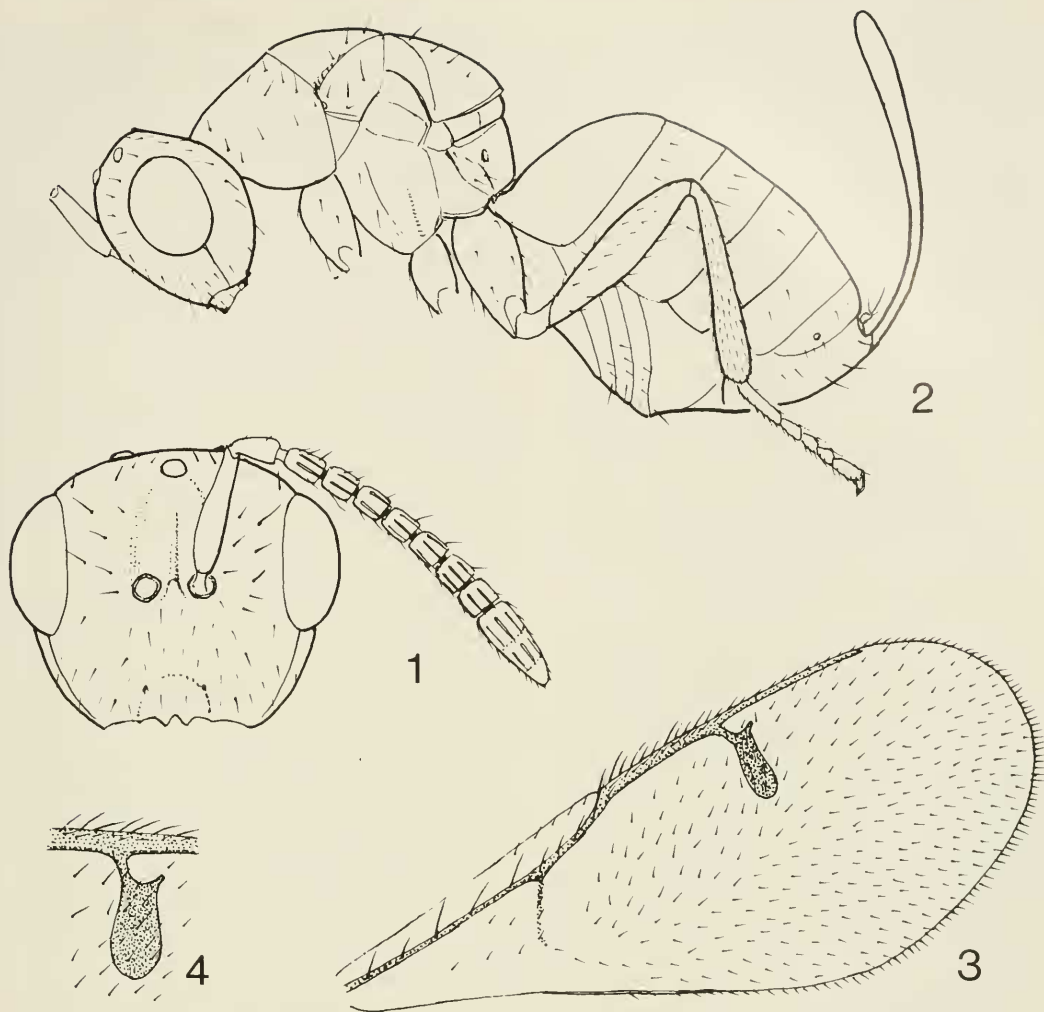
There are approximately 100 described species of *Megastigmus* worldwide (Bou-

ček 1988, Xu and He 1995). Most species are phytophagous (Roux and Roques 1996); exploiting seeds of either coniferous or deciduous trees or shrubs (Milliron 1949; Bouček 1988). Conifers from the Pinaceae, Cupressaceae and Taxodiaceae families are exploited by at least 45 species of *Megastigmus* (Yates 1986, Turgeon et al. 1994, Xu and He 1995, A. Roques, personal communication).

Morphological terminology and measurements generally follow those of Bouček (1988). The following abbreviations are used throughout the text: F1–F7 = funicular segments 1–7; T1–T7 = tergites 1–7.

***Megastigmus thyoides* Kamijo,
NEW SPECIES
(Figs. 1–4)**

Female.—Body length 1.4 to 1.7 mm. Body brownish yellow: T1–T4 each with vague dark band. Antenna with pedicellus and flagellum dark brown. Wings subhya-



Figs. 1-4. *Megastigmus thyoides*. 1, Frontal view of female head and antenna. 2, Lateral view of female. 3, Forewing of female. 4, Stigmal vein of forewing of male.

line; veins including basal vein dark brown. Ovipositor sheath blackish.

Head in dorsal view about 1.6 times as broad as long, with occiput weakly emarginate and temples roundly converging. POL nearly 1.6 times OOL. Vertex weakly strigate; ocellar area, frons and lower face strigate-reticulate. Head covered with sparse, black setae, but most setae on lower face whitish. Eyes separated by 1.6 times their height. Malar space slightly longer than half height of eye. Antennal scrobes almost reaching median ocellus; toruli sit-

uated exactly in middle of height of head (Fig. 1). Scape reaching level of vertex; combined length of pedicellus and flagellum 1.2 times breadth of head; flagellum weakly clavate; anellus slightly transverse to quadrate; F1 nearly as long as pedicellus; F7 quadrate to slightly transverse; sensilla disposed in 1 row on each funicle segment.

Thorax strongly arched in lateral view (Fig. 2), 1.5 to 1.6 times as long as broad in dorsal view. Pronotum nearly 1.6 times as broad as long, strigate-reticulate. Mesoscutum a little longer than pronotum; mid-

lobe with distinct, raised reticulation, and 2 or 3 black setae present on each side; scapulae reticulate. Scutellum as long as broad, sculptured like mesoscutal mid-lobe, with 3 or 4 setae on each side; frenum more coarsely reticulate, with frenal line indistinct, almost straight. Propodeum with strongly raised reticulation, sometimes median carina present; callus with 3 or 4 whitish setae. Prepectus with oblique carina rather indistinct. Mesepisternum and mesepimeron densely reticulate.

Forewing: marginal vein slightly shorter than postmarginal; stigmal vein a little longer than half length of marginal, with stigma slender, basal cell with 1 or 2 apical setae, open in basal half; basal vein distinctly pigmented; speculum rather large, closed below (Fig. 3).

Gaster a little longer than thorax; hind margins of T1 and T2 barely incised medially. Ovipositor sheath weakly clavate, about as long as thorax or 1.6 to 1.9 times as long as hind tibia (Fig. 2).

Male.—Differs from female as follows. Body length 1.4 to 1.9 mm. Ocellar area usually dark brown; scutellum posteriorly, metanotum and propodeum sometimes darker; gaster with T1–T5 more extensively dark brown. Head in dorsal view 1.6 to 1.7 times as broad as long; combined length of pedicellus and flagellum nearly 1.4 times breadth of head; flagellum filiform, covered with denser setae; F7 quadrate to slightly longer than broad. Thorax more slender, sometimes nearly 1.8 times as long as broad. Mid-lobe of mesoscutum with 3 to 5 setae on each side. Scutellum slightly longer than broad. Forewing with stigma slightly broader; basal cell with 2 or 4 setae, open basally (Fig. 4). Gaster much longer than thorax.

Types.—Holotype ♀, Dare County, North Carolina, USA, ex seed of *Chamaecyparis thyoides* collected in 1994, deposited in Canadian National Collection of Insects (CNCI). Paratypes: 14 ♀, 15 ♂, with same rearing data as holotype. 2 ♂ and 2 ♀ paratypes deposited in the National Museum of Natural History, Smithsonian Institution, and in the

personal collection of JJT at the Canadian Forest Service-Great Lakes Forestry Centre, Sault Ste. Marie, Ontario, Canada. Another pair is at Hokkaido University, Sapporo, Japan. The remainder of the paratypes are deposited in the CNCI.

Distribution.—Dare, Wayne and Perquimans Counties, North Carolina, U.S.A.

Host.—Seeds of Atlantic white cedar, *Chamaecyparis thyoides* (L.) B.S.P. (Cupressaceae).

Discussion.—*Megastigmus thyoides* Kamijo is the first record of this genus exploiting seeds of Cupressaceae in the Nearctic Region. In the Palaearctic Region however, seeds of Cupressaceae are host to thirteen species of *Megastigmus*. Eight of these thirteen species infest seeds of *Juniperus* spp. Seeds of *Cupressus* spp., *Chamaecyparis* spp. and *Thujaopsis* spp. are exploited by three, one and one species of seed chalcid, respectively (Zerova and Serogina 1994, Xu and He 1995). There is also a record of this genus exploiting seeds of Cupressaceae in the Oriental Region, where *M. cupressi* Mathur infests seeds of *Cupressus torulosa* Don. (Mathur 1955).

Megastigmus thyoides Kamijo is characterized by the reticulate sculpture on the head and thorax, the elongate stigma, the short ovipositor, and the strongly arched thorax in longitudinal axis. This species appears closely related to two phytophagous species from Japan, *M. chamaecyparidis* Kamijo and *M. thuyopsis* Yano that exploit seeds of *Chamaecyparis obtusa* (Sieb. and Zucc.) Endl. and *Thuyopsis dolabrata* Sieb. and Zucc. (Cupressaceae), respectively (Kamijo 1962). All three species have a row of sensilla on all funicular segments, a brownish-yellow body, and the pronotum, mesoscutum and scutellum weakly sculptured with a small number of black bristles. However, unlike *M. thyoides*, the two Japanese species have the head, pronotum and mesoscutum weakly strigate, a weakly arched thorax, nearly 1.9 times as long as broad in dorsal view, a stigma less slender, and ovipositor sheaths 1.7 times as long as

thorax in *M. chamaecyparidis*, and 1.3 times as long in *M. thuyopsis*.

Megastigmus thyoides also resembles the Nearctic species *M. hoffmeyer* Walley, which feeds in seeds of *Tsuga canadensis* (L.) Carr. (Pinaceae) (Milliron 1949) and the Japanese *M. tsugaphilus* Kamijo (Kamijo 1962). Both *M. thyoides* and *M. hoffmeyer* have a body entirely brownish yellow and an elongate stigma, but according to the redescription given by Milliron (1949), *M. hoffmeyer* has a longer ovipositor, pronotum and mesoscutum rugulose, and distal funicle segments longer than *M. thyoides*. *Megastigmus tsugaphilus* also has a brownish body and a strongly arched thorax which resembles that of *M. thyoides*. In *M. tsugaphilus*, however, besides the long ovipositor and the strigate sculpture on the head and thorax, the funicular segments have two rows of sensilla, the basal cell of the forewing has many setae, and the mid-lobe of scutellum usually has five setae on each side (Kamijo 1962).

The most recent key for the Nearctic species of *Megastigmus* is that by Milliron (1949). Females of *M. thyoides* key best at a slightly modified (**in bold**) couplet 3 of Milliron's key.

- 3. Pronotum **weakly arched** above and without sharp transverse rugae; **mid-lobe of** mesoscutum with fine, reticulate sculpture; stigma narrow-elongate, **pointed or rounded on lower margin**; small species (1.2 to 2.2 mm.) 3a
- Pronotum **more strongly arched** and usually with at least one distinct transverse ruga; **mid-lobe of mesoscutum transversely rugulose or sometimes shingled**; stigma more or less oval or circular 5
- 3a. Stigma narrow-elongate oval with lower margin rounded (Fig. 3); setae on head and thoracic dorsum black *thyoides* Kamijo
- Stigma surrounded by cloud or somewhat triangular, with lower margin pointed (Milliron 1949: Figs. 7, 9); setae on head and thoracic dorsum pale 4

Males of *M. thyoides* key out at couplet 43. Some characters of *M. thyoides* used in

the following modified couplet are not included in our description (e.g., length of hind legs).

- 43. Hind tarsus distinctly greater than two-thirds of the hind tibia; proximal tarsal segments rather long, the dorsal measurement of the first about 1 2/3 that of the second 43a
- Hind tarsus nearer to two-thirds as long as the hind tibia; proximal segments of hind tarsus comparatively shorter than above .. 44
- 43a. Pronotum nearly as long as wide; mesoscutum and scutellum transversely rugulose; head and thorax brownish yellow with blackish markings *rafni* Hoffmeyer
- Pronotum distinctly wider than long; mesoscutum and scutellum densely reticulate; head and thorax entirely brownish yellow *thyoides* Kamijo

Etymology.—This species is named after its host, *C. thyoides*.

Biology.—This species is a phytophagous insect developing in seeds of its host. Most species of this genus developing in conifer seeds have a univoltine life cycle, overwintering as a 5th instar in seed on the ground (Hedlin et al. 1980). Thus far, only *M. spermotrophus* Wachtl has been shown to oviposit and develop in unfertilized seeds (Niwa and Overhulser 1992, Rappaport et al. 1993). Whether this species also develops in unfertilized seeds of *C. thyoides* will be investigated together with its potential for prolonged diapause, a mechanism used by several species of this genus to compensate for annual fluctuations in cone abundance (Roux 1995).

Seed cones of *C. thyoides* were collected in late-October early-November 1994 from various sites (each identified with a different seed lot number) in North Carolina (Table 1). Cones were dried at room temperature and the seeds extracted. A subsample of seeds from each lot was spread as uniformly as possible on a sheet of Kodak Industrex 620 X-ray paper and irradiated with a Hewlett Packard Faxitron 43805N X-Ray system for 30 sec at 15 Kv and 3 mA. The exposed paper was developed using a model P-1 Ko-

Table 1. Quality of *C. thyoides* seeds collected in North Carolina together with infestation rates by *M. thyoides*.

Collection Site	County	Seed Lot Number	Type of Stand	Filled (%)	Empty (%)	Infested by <i>M. thyoides</i>
Sasser Tract (Goldsboro)	Wayne	WC-NC 94-6A	5-y-old tree farm	37.7	58.5	3.8
Sasser Tract (Goldsboro)	Wayne	WC-NC 94-6B	5-y-old tree farm	28.0	67.4	4.6
Milltown Road (East Lane)	Dare	WCNC 94-7	Natural stand	7.6	81.2	11.2
D-7 (Elizabeth City)	Perquimins	WCNC 94-8	Plantation	35.7	63.2	1.1
Dare Bomb Range (Stumpy Point)	Dare	WCNC 94-9	Stand-logged	10.0	75.0	15.0
Average				23.8	69.0	7.2

dak Industrex Instant Processor. On each radiograph an acetate overlay with 1 cm grid intervals and coordinates from a random number table were used to locate the centre points for 10, non-overlapping circles (diam. of 3 cm). A 10x hand lens was used to examine the radiographic images and determine for each seed lot the numbers of filled, empty and chalcid-infested seeds within each circle.

The proportions of filled, empty and chalcid-infested seeds varied substantially among seed lots (Table 1). On average, almost 70% of the seeds from each seed lot were empty. The true impact, as defined by Rappaport et al. (1993), of *M. thyoides* could not be assessed because the number of sound seeds in chalcid-excluded cones could not be determined. Nonetheless, seed infestation rates by *M. thyoides* appear relatively low, never exceeding 15% in a seed lot. These rates are similar to those reported for other species of *Megastigmus* exploiting conifers in their native range (Hedlin et al. 1980, Roques 1983).

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